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# THE MENDELIAN BEHAVIOR OF AUREA CHARACTER IN A CROSS BETWEEN TWO VARIETIES OF NICOTIANA RUSTICA

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## Introduction

The species of tobacco *Nicotiana rustica* comprises a number of more or less distinct varieties. One of the more characteristic varieties which was received from Russia (S. P. I. 35080) is a light, yellowish-green type with distinctly white stems and midribs. In these respects this type of *N. rustica* resembles the well-known White Burley variety of *N. tabacum*. According to Splendore,[1] who has described it in detail, this white-stemmed variety of *N. rustica* is grown commercially in Russia (Makorka, Bakoun, Kolmak, Tseco, etc.) as a pipe and cigarette tobacco. In this variety of *N. rustica*, the stems of young plants—especially if they have been somewhat etiolated by crowding—are almost snow white. A cross section of the stems of such plants one month old reveals the fact that this whiteness is not merely superficial, but extends entirely through the stems, whereas in green varieties of *N. rustica* the internal structure of the stems is green throughout. The cotyledons are decidedly chlorotic and the leaves have a pale yellowish-green, chlorotic appearance which becomes more marked as the plants approach maturity. As a matter of convenience, the writer has applied the term "aurea" to this peculiar, varietal form of chlorosis.[2]

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[1] Splendore, A., "Due Particolore Forme Di N. Rustica Brasilia Chwitzent e Kapa Magiara," *Boll. Tech. Della Colt. Dei Tabachi del R. Inst. sperimentale, Scafati* (Salerno), XI, No. 2, 1912.

[2] This type of *aurea* appears to be quite distinct from the type of *aurea* described by Lodewijks as having occurred suddenly in plants of *N. taba-*

## DOMINANCE OF GREEN PLANT COLOR IN $F^1$ PLANTS OF CROSSES

In 1914 the writer made reciprocal crosses of this white-stemmed, chlorotic *aurea* type of *N. rustica,* with green-stemmed, green-leaved type, and several hundred $F^1$ plants were grown in the field at Arlington, Va., during the season of 1915. All the $F^1$ plants were green in color, whichever type was used as the seed-bearing parent. It was at once evident that the white-stemmed, chlorotic, *aurea* character behaved as a simple recessive to normal greenness of stem and leaf. To determine more fully the Mendelian behavior of this cross an analysis of the $F^2$ and $F^3$ generations was made.

## SEGREGATION IN $F^2$ PLANTS

In the $F^2$ generation, green- and white-stemmed *aurea* plants appeared. So distinct is the white-stemmed recessive that four or five weeks after germination, the young plants can be readily distinguished from the green-stemmed types. This made the growing and handling of large numbers of plants a comparatively easy matter, since it was only necessary to grow them to the size of small seedlings and obtain counts when they were four or five weeks old. In the following table an analysis of 25,000 $F^1$ plants is shown.

From this data it is evident that the recessive white-stemmed *aurea* type of *rustica* appeared in numbers approximating very closely the theoretical Mendelian ratio of 25 per cent., since in a population of 25,000 plants, 24.31 per cent. were of the white-stemmed, *aurea* type.

*cum* in Java. He found that this type of *aurea* was inconstant in its inheritance, since *aurea* mother plants always gave progenies consisting of green and *aurea* plants. In crosses between *aurea* and green plants the $F^1$ generation always included *aurea* and green plants. From the inconstant inheritance of this character he concludes that this *aurea* form originated as a mutant with an essentially hybrid constitution. See Lodewijks, J. A., "Erblichkeitsversuche mit Tabak," *Zeitschr. für Induktive Abstammungs. Vererbungslehre,* Vol. 5, 1911, pp. 139–172.

TABLE I

Ratios of Green-stemmed and Recessive White-stemmed aurea Plants in the $F^1$ Generation of the Cross 35080 (White-stemmed) ♀ × No. 1 from India (Green-stemmed) ♂

| Date of Count | Total Number Counted | Number of Green-stemmed | Number of White-stemmed *aurea* | Percent. of White-stemmed *aurea* |
|---|---|---|---|---|
| June 19, 1918.......... | 4,188 | 3,178 | 1,010 | 24.1 |
| May 16, 1918.......... | 1,167 | 887 | 280 | 23.9 |
| May 17, 1918.......... | 417 | 308 | 109 | 24.9 |
| June 24, 1918.......... | 1,955 | 1,476 | 479 | 24.5 |
| June 25, 1918.......... | 279 | 231 | 48 | 17.2 |
| July 1, 1918 .......... | 1,072 | 818 | 254 | 23.6 |
| July 16, 1918 .......... | 747 | 594 | 153 | 20.4 |
| July 18, 1918 .......... | 1,246 | 930 | 316 | 25.3 |
| Sept. 3, 1918 .......... | 2,114 | 1,597 | 517 | 24.4 |
| Oct. 18, 1918 .......... | 2,253 | 1,707 | 546 | 24.2 |
| Oct. 21, 1918 .......... | 2,673 | 2,035 | 638 | 23.8 |
| Oct. 24, 1918 .......... | 4,556 | 3,400 | 1,156 | 25.3 |
| Oct. 26, 1918 .......... | 2,333 | 1,760 | 573 | 24.5 |
| Totals .............. | 25,000 | 18,921 | 6.079 | 24.31 |

## Behavior of $F^2$ Green Plants and White-stemmed Extracted *aurea* Recessive

Of twenty-eight $F^2$ green plants selected at random the character of the inheritance in the progenies of those showing segregation was noted as follows:

TABLE II

Ratios of Green-stemmed and White-stemmed aurea Plants Appearing in the Progenies of Heterozygous Green-stemmed Plants in the $F^2$ Generation

| Number of Mother Plant | Total Number of Progeny Counted | Number of Green-stemmed Plants | Number of White-stemmed *aurea* Plants |
|---|---|---|---|
| 1 | 414 | 300 | 114 |
| 4 | 401 | 300 | 101 |
| 5 | 462 | 345 | 117 |
| 6 | 392 | 300 | 92 |
| 7 | 887 | 649 | 238 |
| 10 | 403 | 304 | 99 |
| 11 | 395 | 300 | 95 |
| 12 | 386 | 300 | 86 |
| 14 | 399 | 300 | 99 |
| 17 | 390 | 300 | 90 |
| 21 | 410 | 310 | 100 |
| 23 | 397 | 300 | 97 |
| 24 | 660 | 503 | 157 |
| 27 | 995 | 747 | 248 |
| 28 | 739 | 561 | 178 |
| 33 | 393 | 300 | 93 |
| Totals......... | 8,123 | 6,119 | 2,004 |

The green $F^2$ individuals Nos. 2, 3, 9, 13, 15, 16, 18, 19, 20, 25, 29, 30 were homozygous for greenness and gave pure green progenies. A progeny of several thousand plants was grown from each individual.

Of 8,123 plants descending from heterozygous green individuals analyzed in Table II, 2,004 or 24.6 per cent. were white-stemmed recessives. It is evident that these figures for the extracted recessives also approach very closely the theoretical 25 per cent. Mendelian ratio which obtains for contrasted characters in simple hybrids. This ratio of 24.6 per cent. extracted recessives of the *aurea* type descending from green heterozygous $F^2$ individuals, is very close to the ratio 24.3 per cent. obtained in a count of 25,000 individuals descending from $F^1$ plants. Since 12 of the 28 green $F^2$ plants tested were homozygous for greenness and gave all green progenies, it is evident that these were extracted dominants.

The progenies of 20 extracted white-stemmed *aurea* recessives of the $F^2$ generation were also studied. Several thousand plants were grown from each of the 20 individuals, and all proved homozygous for the *aurea* character, etc.

## BEHAVIOR OF BACK CROSSES

First generation plants of the original cross No. 35080 (white-stemmed *aurea*) ♀ × No. 1 from India (green-stemmed *Rustica*) ♂ were now crossed with the parent green-stemmed and white-stemmed *aurea* types.

In the back cross with the recessive white-stemmed *aurea* parent 591 plants were obtained of which 303 were green-stemmed individuals, and 288 were *aurea*. These figures approach the theoretical 1:1 ratio which may be expected in such crosses.

In the back cross with the dominant green-stemmed type, 280 plants were obtained, all of which were green-stemmed.

From these results obtained with the cross between the green-stemmed types of *N. rustica* and the distinctive white-stemmed *aurea* type, it is evident that we are dealing with a clear-cut instance of Mendelian behavior, in which greenness of stem and leaf is contrasted with the character of white stems and a yellowish, chlorotic appearance of the leaves. Since these characteristics are readily distinguished in plants in the seedling stage, only five or six weeks after germination, this cross is especially favorable for the demonstration of simple Mendelian behavior in all its phases. The technique of crossing is simple, and many thousands of seedlings may be grown in a comparatively small area in a short time.

## SUMMARY

In crosses between a distinctive white-stemmed *aurea* type and green-stemmed type of *N. rustica* the following Mendelian relations were found:

In $F^1$ plants the white-stemmed *aurea* type is recessive to the green-stemmed type.

$F^2$ plants segregate into green-stemmed and white-stemmed *aurea* plants. Approximately 25 per cent. of the plants are *aurea* recessive. Some of the green plants are homozygous for greenness of stems, etc., and some are heterozygous, again segregating into green and white-stemmed *aurea* types with the same ratios obtained in the $F^1$ generation. The extracted *aurea* recessives of the $F^2$ generation are homozygous with respect to the character of white stems, etc., peculiar to this type.

In back crosses between a heterozygous $F^1$ plant and the dominant green-stemmed type, the progeny consists of 100 per cent. green-stemmed plants.

In back crosses with the recessive *aurea* type, the progeny consists of green-stemmed and white-stemmed *aurea* plants in approximately the expected ratio of 1 to 1.